WHEEL END CONDITION DETECTION SYSTEM

BACKGROUND OF THE INVENTION

[1] This invention relates to a wheel end condition detection system using an anti-lock braking system (ABS) for identifying a potentially hazardous condition in which the wheel may undesirably separate from the axle during vehicle operation.

[2] Wheel ends including one or more wheels and tires are supported on opposing ends of an axle. Wheel ends are supported by bearings on a hub of the axle. On rare occurrences, one of the components associated with the wheel end may wear or fail, or the wheel end may be improperly installed, and the wheel end may begin to move laterally relative to the axle. Excessive lateral movement may cause the wheel end to become detached from the axle during vehicle operation creating a dangerous condition.

[3] A failure of the bearing supporting the wheel end typically occurs before the wheel end loosens and detaches from the axle. For conventional wheel bearing arrangements, visual warning signs are associated with a failure. For example, the bearing seals will leak providing a visual warning to the operator or vehicle maintenance personnel prior to the wheel end condition deteriorating to the extent that separation of the wheel end may occur. However, unitized bearings do not typically leak at the seals so no such visual warning occurs.

[4] Most modern vehicles utilize ABS for braking of the vehicle. ABS braking systems may detect excessive lateral movement of a wheel end triggering a fault code. The fault code generates an ABS warning light in the vehicle cab indicating to the driver

that there is a problem with the ABS. However, the vehicle operator has no indication as to the nature or severity of the ABS failure. In the case of a fault code generated by excessive wheel end movement, the vehicle operator may continue to operate the vehicle assuming that the vehicle ABS may be serviced at his convenience. As a result, during continued operation of the vehicle the wheel end may detach from the axle resulting in a dangerous condition.

[5] Therefore, what is needed is a wheel end condition detection system that conveys a visual warning to the vehicle operator or maintenance personnel while ensuring safe operation of the vehicle until the wheel end condition is corrected.

SUMMARY OF THE INVENTION AND ADVANTAGES

[6] This invention provides a vehicle axle assembly including a wheel end supported on an axle by bearings. The wheel end may include a tone ring or similar device associated with the hub of the wheel end. A sensor may be mounted on the axle by a bracket. The sensor is located proximate to the tone ring to detect rotation of the wheel end to modulate braking of the wheel end. The ABS may also detect lateral movement of the wheel end relative to the axle using the sensor and tone ring. A fault code is generated during excessive lateral movement of the wheel end relative to the axle. In an example embodiment, the present invention wheel end condition detection system may activate a warning device in the vehicle cab in addition to illuminating an ABS warning light to communicate the severity of the condition to the vehicle operator. Additionally, the detection system may also communicate with a

vehicle control system to limit the vehicle speed by regulating the engine to ensure that the vehicle is not operated at an unsafe speed until the wheel end condition is corrected.

[7] Accordingly, this invention provides a wheel end condition detection system that conveys a visual warning to the vehicle operator or maintenance personnel while ensuring safe operation of the vehicle until the wheel end condition is corrected.

[8]

BRIEF DESCRIPTION OF THE DRAWINGS

[9] Other advantages of this invention can be understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[10] Figure 1 is a schematic view of one example of this inventive wheel end condition detection system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[11] A vehicle axle assembly 10 is schematically shown in Figure 1. The assembly 10 includes an axle 12 having a spindle 14. The wheel end assembly 15 includes a hub 16 supported on the spindle 14 by bearings 18. A wheel 20 is secured to the hub 16 by fasteners, and the wheel 20 supports a tire for rotation about an axis A. The wheel end assembly 15 is retained on the axle 12 by a nut 19 or any other suitable configuration, as is known in the art.

[11] Although a non-drive, non-steer axle arrangement is shown, it is to be understood that this invention may be used with drive axles, steer axles and trailer axles. It will also be understood by one of ordinary skill in the art that other wheel end configurations may be used with this invention.

[12] The vehicle axle assembly 10 also includes an ABS assembly 24, as is well known in the art, for detecting the rotation of the wheel end assembly 15 for use during braking and other vehicle maneuvers. The ABS assembly 24 may include a tone ring 26 associated with the wheel end assembly 15. For example, the tone ring 26 may be mounted onto the hub 16 for rotation with the hub 16. The tone ring 26 may include notches about its circumference that indicate the wheel end rotational speed and other information, as is known in the art. The ABS assembly 24 includes a sensor 28 mounted on the axle 12 by a bracket 30. The sensor 28 is mounted proximate to the tone ring 26 to detect the rotation of the wheel end assembly 15 by magnetically "reading" the notches as they pass the senor 28, as is known in the art.

[13] An ABS controller 32 is connected to the sensor 28 for detecting information useful for the ABS and other vehicle control systems. For example, the ABS control system 32 may detect excessive lateral movement of the wheel end assembly 15 relative to the axle 12 and trigger a fault code indicating that the sensor 28 is out of lateral alignment with the tone ring 26. Excessive lateral movement may be evident from a deteriorating electrical signal from the sensor, for example. The ABS controller 32 may activate an ABS warning device 34 in the vehicle cab 35, such as illuminating an ABS warning light. The ABS controller 32 may be integrated with other systems controllers.

[14] The ABS warning light is intended to prompt the vehicle operator to seek a service or maintenance technician to correct the ABS. However, the ABS warning device 32 typically does not convey the urgency of the problem within the ABS, and therefore, the vehicle may operator may continue to drive the vehicle until a failure occurs, for example, until the wheel end assembly 15 becomes detached from the axle. To this end, this invention incorporates additional warning devices and controls to ensure sufficient warning to the vehicle operator and continued safe operation of the vehicle until the ABS is properly serviced.

[15] Excessive lateral movement of the wheel end assembly 15 relative to the axle 12 may occur for example, as a result of failing bearings 18. In the case of a unitized bearing, the bearing failure may not be apparent to the vehicle operator or service technician. The sensor 28 detects excessive lateral movement of the wheel end in the direction X as the tone ring 26 moves laterally relative to the sensor 28. When the lateral movement X reaches a pre-determined value the ABS controller 32 will register a fault code and illuminate a conventional ABS warning device 34, such as an ABS warning light in the vehicle cab 35. Instead of, or in addition to the warning device 34, the ABS controller 32 may also activate a wheel end condition warning device 36 in the vehicle cab 35. The wheel end condition warning device 36 may be an audio and/or visual warning that conveys a clear message to the vehicle operator as to the nature and severity of the wheel end condition. As a result, the vehicle operator will more likely seek prompt service of the ABS.

[16] Other vehicle components may also be controlled as a result of the ABS controller 32 registering an excessive lateral movement fault code. For example, the ABS controller 32 may interface with a vehicle engine 40 through a vehicle or engine control system 38 to limit the vehicle speed. The engine power may be reduced to maintain the vehicle below a creep speed, for example, below five miles per hour. In this manner, the present invention wheel end condition detection system ensures safe operation of the vehicle until the ABS is properly serviced even if the warning devices 34 and 36 are ignored.

[17] The invention has been described in an illustrative manner, and it is to be understood that the terminology that has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.